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Collaborating to develop joint water, sanitation and hygiene (WASH) and neglected tropical disease (NTD) sector monitoring: an expert consultation

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Background: Joint monitoring between the water, sanitation and hygiene (WASH) and neglected tropical disease (NTD) sectors presents an opportunity for enhanced collaboration and progress towards shared objectives. Taking forward outputs from global WASH and NTD Roundtables, we engaged experts in a consultative process of identifying measurable priority indicators for joint monitoring.

Methods: We used a Delphi method for conducting expert consultation and developing consensus. Experts were invited to participate through purposive and snowball sampling, and open solicitation at key sector meetings. Participating WASH and NTDs experts represented a diversity of interest groups, including NTD and WASH field staff and government stakeholders from endemic countries, bilateral and multilateral development agencies, non-governmental organizations, and academic institutions. Four rounds of consultation were conducted via online surveys.

Results: Between 55 and 69 experts participated in each round of consultation. Seven core measurable indicators emerged as priorities for inclusion in joint monitoring for the NTD sector.

Conclusion: Our findings provide insight on the development and implementation of joint monitoring frameworks that can be integrated into existing programme level monitoring.

Keywords: Hygiene, Monitoring, NTDs, Sanitation, WASH, Water

Introduction

Neglected tropical diseases (NTDs), endemic in 149 countries, are a major global health concern that disproportionally impact the poor.[1] It is estimated that over one billion people globally are affected by NTDs, while many more are at risk of infection.[1] While not usually fatal, NTDs are associated with malnutrition,[2,3] stunted childhood development,[4] chronic disability,[5] poor mental health,[6] stigma and social exclusion,[7,8] and lost employment and educational opportunities.[3]

Successful control and eventual elimination or eradication of NTDs requires primary prevention, morbidity management and treatment-based interventions.[9] Primary prevention includes community- and school-based interventions to improve water, sanitation, and hygiene (WASH) infrastructure and behaviours. Numerous NTD transmission routes can be interrupted with improved WASH, and WASH is vital for NTD treatment and care.[10–14]

In order to enhance coordination, communication and collaboration between WASH and NTDs stakeholders, a WASH and NTD Roundtable was hosted by the Bill & Melinda Gates Foundation in 2012. The meeting resulted in the development of a shared long-term vision: 'Disease-free communities that have adequate and equitable access to water and sanitation, and that practice good hygiene'.[15] In identifying next steps, participants agreed opportunities for collaboration around advocacy, policy and communications, capacity building and training, mapping, data collection and monitoring, and research. Progress was made following the 2012 meeting; however, challenges remained in the areas of joint monitoring and research.[16]

A follow-up WASH and NTD Roundtable was hosted in 2014 by the Sanitation and Hygiene Applied Research for Equity (SHARE) Consortium to 'significantly progress collaboration, coordination, and cooperation between the WASH and NTDs sectors in the areas of mapping, data collection, monitoring,

and research'.[17] Monitoring was prioritised due to the assumption that a joint monitoring framework, or at least information-sharing, could incentivise collaboration by helping each sector achieve its objectives, facilitate cross-sectoral planning, and enhance accountability.[10] The focus of the 2-day meeting was to address gaps in progress by analysing existing monitoring frameworks, identifying barriers to joint monitoring and information sharing, and initiating efforts to develop a core set of indicators to support collaboration. To carry forward outputs from the 2014 Roundtable, we engaged experts in a consultative process of identifying measurable priority indicators for joint WASH and NTD monitoring. While we recognize the need for joint monitoring across both sectors, here we focused on joint monitoring from the perspective of the NTD sector monitoring WASH related indicators.

Methods

Delphi method

The development of the proposed joint indicators was guided by a series of surveys using the Delphi method, a systematic approach for conducting expert consultations and developing consensus.[18] The method, initially developed by the Rand Corporation in the 1950s, is widely used and accepted for gathering data from respondents within their domain of expertise and coming to consensus.[19] Although there are no universally accepted requirements for using this method,[20] it has been used across diverse fields of study and is considered a robust mechanism for collecting and distilling knowledge from a group of experts. For example, the Delphi method was recently applied in the WASH sector by UNICEF to determine what child faeces disposal behaviours should be considered 'safe'.[21] Challenges of the Delphi method include difficulties around subject selection, time frames for conducting and completing a study, the possibility of low response rates, and unintentionally guiding feedback from the respondent group.[19]

Sampling experts

Experts were engaged based on their knowledge of NTDs, WASH, or both, through purposive and snowball sampling and open solicitation at key meetings. We initially solicited participants of the 2014 WASH and NTDs Roundtable, as well as members from several global WASH and NTDs working groups. These groups included the NTD Non-Governmental Development Organisation (NGDO) Network (NNN) WASH working group, the International Coalition for Trachoma Control, the Soil Transmitted Helminths (STH) Coalition, the WHO Schistosomiasis Scientific Working Group, WHO WASH and NTDs Joint Working Group, and participants of the 2015 World Water Week conference in Stockholm and the Water and Health Conference in Chapel Hill, USA. Conference participants included representatives from national water ministries, bilateral and multilateral development agencies, NGDOs and academic institutions. NTD and WASH field staff and government stakeholders from endemic countries were also invited to participate through meeting engagement and by encouraging agency headquarter staff to share the surveys within their organisations and countries of operation. Finally, other experts from specific scientific or policy oriented organisations were invited to participate, including the United States Agency for International Development (USAID), UK Department for International Development (DFID), WHO, the Bill & Melinda Gates Foundation and the United Nations University - Institute for Water, Environment and Health.

Experts received an email invitation to participate, outlining the purpose, methods, expected outcomes of the survey, expectations of involvement, and measures that would be taken to ensure confidentiality and anonymity of responses. For rounds one through three, the invitation was sent via electronic mail from the chairperson of the NNN WASH working group on behalf of the study team. The fourth round, focused on specific NTDs or issues, was sent out through chairpersons of the relevant disease or thematic working group. After each round of data collection, the study team circulated a brief anonymous summary of the results to all participants, which included quantitative analysis, any noteworthy qualitative comments, and changes or additions for inclusion in the next round.

Data collection and analysis

We started with 64 indicators (see indicators presented in Table 1) derived from existing WASH monitoring frameworks and the discussions at the 2014 WASH & NTD Roundtable (see Chitty & Waite[17]). These included process indicators, which could be collected at a country or program level in order to identify governance and coordination mechanisms, and outcome indicators, which could determine the progress of programmes in achieving changes to NTD-related WASH behaviours and services. The outcome indicators were divided into six main categories: each WASH component (water, sanitation, hygiene) split into two settings – community and school. The initial set of 64 indicators was reduced to a final proposed list of seven by assessing the priority of indicators (Round 1) and the feasibility of data collection associated with these indicators (Round 2), and by reconciling priority and feasibility and establishing consensus around the final set of indicators presented (Round 3). The final set of seven indicators included only general WASH indicators that did not account for some key behaviours required for specific NTDs (e.g., facial cleanliness for trachoma). As such, we added a 4th Round to demonstrate an awareness of the need for additional disease specific WASH behaviour indicators, and to initiate consensus building on a supplemental list of indicators for specific NTD programs, including trachoma, STH, schistosomiasis, and disease management, disability and inclusion (DMDI). All consultations were conducted using an online survey tool (Survey Monkey, Palo Alto, CA, USA) and the list order of indicators and metrics were randomized. During each round of consultation, participants were provided with the opportunity to justify their selections, or provide comment on proposed indicators or metrics.

In Round 1, participants ranked indicators in order of 'importance' for joint WASH and NTDs monitoring (from most important to least important). Each indicator was analysed based on average rank, as well as percentage of responses across the highest three ranking options (1st, 2nd or 3rd) within its designated category (by process indicators, community WASH and

Table 1. Initial list of indicators and results of indicator rankings used in Round 1 (n=69)

Indicators	Average Rank[a]	% in top three[b]
Process indicators		
NTD National and District master plans include WASH activities, targets, and indicators	3.62	58
There is mutual representation of WASH and NTDs on National and District-level NTD Taskforces and WASH Sector coordination groups	4.09	49
WASH sector National and District programs include NTD activities, targets, and indicators	4.32	38
School hygiene curricula incorporate NTD-relevant behaviors (wearing shoes, face washing, hand washing with soap at critical moments, and fly control)	4.32	41
Community hygiene programs incorporate NTD-relevant behaviors (wearing shoes, face washing, hand washing with soap at key moments, and fly control)	4.45	35
WASH sector activities explicitly target NTD endemic areas	4.68	25
NTD outreach activities (MDA/PCT, surgical outreach) incorporate hygiene and sanitation messaging	4.68	32
Meetings are held between Ministry of Health and Ministry of Water officials	5.84	23
Outcome indicators: community water		
Improved water source is free from fecal contamination	3.44	52
Water is consistently available in sufficient quantities for all domestic uses	3.66	49
Access to and use of water source is equitable (across SES, disease stigma, caste/class, and gender)	3.87	48
Improved water source is located such that it is within 30 minutes of collecting (including round trip walking and waiting time)	4.15	51
Improved water source is located on-site	4.59	45
Exclusive use of improved water source for drinking and preparing food	4.97	25
Water storage containers are covered (to prevent fecal contamination and mosquito breeding)	5.25	16
Exclusive use of improved water source for personal hygiene (face washing, limb washing, laundry)	6.07	10
Outcome indicators: school water		
Water is available for children at school through-out the year	2.25	83
Improved water source is located on-site	2.52	67
Improved water source is free from fecal contamination	3	62
Exclusive use of improved water source for drinking and preparing food	4.23	26
Water storage containers are covered (to prevent fecal contamination and mosquito breeding)	4.4	26
Exclusive use of improved water source for personal hygiene (faces washing, hand and limb washing, laundry)	4.6	19
Outcome indicators: community sanitation		
Environmental:		
Community is feces free (all community members exclusively use a toilet facility, and there are no visible human open defecation sites)	2.68	65
Exclusive use of toilet facility by all members of the household	3.54	51
Human waste is not discharged into the environment	3.57	51
Safe disposal of children's feces (child used toilet or feces put/rinsed into toilet)	4.15	32
Community compound is free of visible human feces	4.35	32
Community compound is visibly clean (well swept, garbage pits and drying racks are present and in use for fly control)	4.77	26
Community declared 'open defecation free'	4.94	26
Point of use:		
Functioning toilet present is in use	2.52	71
Presence of a functioning, clean toilet	3.17	54
Toilet is accessible to people with physical impairments where required	4.17	35
Presence of a functioning, basic toilet	4.34	36
Toilet facility is not shared by more than 5 families, or 30 people	4.36	25
Toilet facility includes vector controls (fly and mosquito)	4.39	38
Presence of a functioning toilet	5.05	20

Continued

Table 1. *Continued*

Indicators	Average Rank[a]	% in top three[b]
Outcome indicators: school sanitation		
Environmental:		
School is feces free (all students exclusively use a toilet facility, and there are no visible human open defecation sites)	2.14	74
Exclusive use of toilet facility by all pupils during the school day	2.71	64
Human waste is not discharged into the environment	3.11	57
School compound is free of visible human feces	3.48	45
School compound is visibly clean (well swept, garbage pits and drying racks are present and in use for fly control)	3.57	43
Point of use:		
Functioning toilet present is in use	3.92	65
Presence of a functioning, clean toilet for student use	4.09	61
There are separate toilets for boys and girls	4.2	67
Toilet structure and location is sufficient to provide privacy and safety	4.35	70
Toilets are present in a ratio of 25:1 for girls and 50:1 for boys with a urinal present	5.29	52
Presence of a functioning, basic toilet for student use	5.32	46
At least one toilet is accessible to people with physical impairments	5.66	41
Toilet facilities include vector controls (fly and mosquito)	5.98	36
Presence of a functioning toilet for student use	6.17	33
Outcome indicators: community hygiene		
Hand washing with soap and water following toilet use and before eating	2.57	71
Hand washing station with water and soap is present and near toilet	3.4	51
Community members have basic knowledge of hygiene practices	3.43	54
Hand washing station with water and soap is present	4.06	38
Children have clean faces	4.38	32
Children wear basic footwear	4.89	20
Hand washing station with water is present	5.26	17
Outcome indicators: school hygiene		
Hand washing with soap and water following toilet use and before eating	2.45	70
Hand washing station with water and soap is present and near toilet	2.55	71
Students have basic knowledge of hygiene practices	3.27	51
Hand washing station with water and soap is present	4.71	22
Children wear basic footwear	4.73	23
Children have clean faces	4.77	20
Hand washing station with water is present	5.52	13

MDA: mass drug administration; NTD: neglected tropical disease; PCT: preventive chemotherapy and transmission control; SES: socioeconomic status; WASH: water, sanitation and hygiene.
[a] Indicators are ranked within each category between the number of indicators within the group. The best possible indicator ranking is 1.
[b] The percentage of responses across the highest three ranking options. The higher the percentage the more the indicator was ranked as 1st, 2nd, or 3rd priority by survey participants.

school WASH outcome indicators separately). Due to the high number of indicators initially presented within categories of community and school sanitation, indicators were further separated for data collection and analysis by wider environmental and facility point of use sanitation related indicators. The highest ranked indicators were retained for Round 2, with the number retained based on the clustering and diversity of responses.

In Round 2, participants identified the feasibility of data collection for potential metrics of indicators retained from Round 1 (from 'very feasible' to 'very challenging' using a Likert scale questionnaire). Potential metrics were extracted from existing WASH monitoring programming, or were devised by the study team based on existing programmatic experience and feedback from experts throughout the consultation process. Each metric was analysed based on average rank and percentage of responses to 'very or somewhat feasible' within its designated category (by process indicators, and community water, sanitation and hygiene, and school water, sanitation and hygiene

outcome indicators separately). In order to avoid skewing results, responses to the category of 'not sure' were treated as missing data and not entered into the average calculation. In all but two cases, indicators with proposed metrics which received below an 80% responses to 'very or somewhat feasible' were dropped for Round 3. Participants' feedback and suggested wording was taken into consideration for Round 3.

In Round 3, participants were provided with data from the previous rounds and were asked to rank indicators with their associated metric from most to least important in terms of inclusion in joint monitoring frameworks. Each indicator/metric pair was analysed based on average rank within its designated category (by process indicators, and community and school outcome indicators). One process indicator and three outcome indicators from both community and school settings were extracted as the final core set of indicators for joint monitoring.

For Round 4 of data collection, indicators and metrics relevant for specific disease prevention and management aspects were re-introduced and collated by disease/issue group. Disease specific indicators were developed based on qualitative feedback throughout the consultation, existing indicators, and expert opinion. Consultation was conducted with four groups – trachoma, STH, schistosomiasis, and DMDI (a cross-cutting group within the NNN that includes representation from leprosy, lymphatic filariasis, trachoma, disability and WASH stakeholders). Experts from each group were asked to rank available indicators in order of importance for joint monitoring, to indicate to what extent associated metrics could be feasibly used in practice, and to state whether or not they agreed with the proposed wording of indicators and associated metrics. Given the typical overlap of experts working on STH and schistosomiasis, a combined survey including questions on both disease groups was distributed to a collective group of experts. Each indicator/metric pair was analysed based on average rank and percentage of responses to 'very or somewhat feasible' and 'yes I agree with wording of indicators/metrics' within its grouping (trachoma, STH, Schistosomiasis, and DMDI).

Results

Sixty-nine experts participated in Round 1. Results are available in Table 1. The highest ranked process and outcome indicators in each grouping were identified. The process indicator, 'NTD national and district master plans include WASH activities, targets and indicators' had the best overall score (3.62) and was found in 40 (58%) of respondent's top three indicators. A set of priority outcome indictors emerged in several categories. For environmental sanitation in school and community settings, areas being 'faeces free' scored well above all others. For hygiene indicators, 'hand washing with soap and water following toilet use and before eating' emerged as a priority for school and community settings, although in school settings two other indicators scored well. Amongst water indicators, 'water is available for children at school through-out the year' emerged as a priority indicator in school settings, while in community settings scores were more evenly distributed. Based on the qualitative feedback received from survey comments, some of the language of priority indicators was slightly modified and improved for Round 2.

Fifty-five experts ranked the feasibility of metrics for the highly rated indicators identified from Round 1 (Table 2). In some categories, such as school sanitation and hygiene, the most feasible metric identified was for the highest priority ranked indicator. In other categories, such as community water, the most feasible metric identified was for the lowest priority indicator. Qualitative comments from experts highlighted a general concern regarding reliability of self-reporting (relatively feasible) and feasibility of collecting observational data (more robust but harder and costlier to collect), particularly for hygiene and sanitation behaviours. As stipulated in methods, indicators with proposed metrics with a feasibility score below 80% were dropped for Round 3. However, an exception was made for the top priority indicator in community water: – 'Improved water sources free from faecal contamination' – since it emerged as the clear priority indicator from Round 1, and the percentage of respondents that thought this indicator was feasible was reasonably satisfactory at 78%. For the 15 indicators identified for inclusion in Round 3, the metric with the highest feasibility ranking was extracted. Where two metrics' feasibility had the same percentage of responses to 'very or somewhat feasible' (e.g., the metrics for the indicator 'students have basic knowledge of hygiene practices') the average score was used to identify the more feasible metric for inclusion in Round 3. For the indicator 'there is mutual representation of WASH and NTDS on National and District-level NTD Taskforces and WASH sector coordination groups', the original two metrics were combined into one metric for Round 3, becoming 'there is mutual representation of WASH and NTDs on National and District-level NTD task forces and WASH sector coordination groups'.

Results from Round 3, which included 60 experts, are shown in Table 3. The process indicator as well as three indicators within community and school settings with the best average ranks were extracted as the final core set of indicators for joint WASH and NTD monitoring (see indicator and metric pairs in Table 3). All indicators identified were general enough to be relevant across many NTDs. Round 4 attempted to identify any additional indicators that related to disease/issue specific WASH behaviours and services.

Results from Round 4 are presented in Table 4. For trachoma, the indicator 'children have clean faces' measured by the percentage of children that had clean faces (free of dirt and/or nasal and ocular discharge) was ranked as the most important (average score 1.3), but only 67% thought it was somewhat or very feasible. There was sufficient agreement on the wording (83%) for the indicator. For STH, 77% of respondents considered all indicators to be very or somewhat feasible. 'Handwashing before eating,' measured by observation of a handwashing station with water and soap, was considered the most important (average score 1.6), and there was moderate agreement on the wording (77%). For schistosomiasis, the preferred indicator was 'community is faeces free' (average score 1.5), measured through observation of households with no evidence of faeces in the living area, although only 67% thought data collection would be very or somewhat feasible, and the same proportion agreed with the wording. For DMDI, the preferred indicator was 'Water is consistently available in sufficient quantities to do activities of daily living and self-care' (average score 1.6), measured as self-report that the water

Table 2. Round 2 results of metric feasibility rankings for priority indicators extracted from Round 1 (n=55)

Priority indicators[a] and associated metrics	% of 'very or somewhat feasible' responses	Average rank[b]
Process indicators		
NTD sector National and District masterplans include WASH activities, targets, and indicators		
Water, sanitation and hygiene are referenced and operationalized throughout NTD program strategies and plans (within targets, activities and monitoring) - self reported by NTD program coordinator	87	1.71
There is mutual representation of WASH and NTDs on National and District-level NTD Taskforces and WASH Sector coordination groups		
If there are NTD task forces or groups in existence, representatives from relevant organizations and ministries for water, sanitation and hygiene participate - self reported by task force chair	90	1.70
If there are WASH sector coordination groups in existence, representatives from relevant NTD organizations and health ministries participate - self reported by coordination group chair	90	1.67
Outcome indicators: community water		
Improved water source is free from fecal contamination		
The water is from an improved water source, and assumed free from fecal contamination by nature of its construction - observational	78	1.83
Water from source meets WHO guideline values for *Escherichia coli* (less than 10 cfu *E. coli*/100 ml) - water sampling and testing	55	2.40
Water is consistently available in sufficient quantities for all domestic uses		
The water source provides enough water for the needs of the household, including water for drinking, hand washing, bathing, laundry, food preparation, morbidity management where needed, etc. - self reported by households	81	1.83
Water point was non-functional ≤2 days in the last 2 weeks - self reported by households	78	1.84
All community members are able to access water source		
Water source is accessible to all members of the community - self reported by households and observational (consider location and physical structure of the water source, as well as potential social exclusions)	75	1.92
Improved water source is located such that it is within 30 minutes of collecting (including round trip walking and waiting time)		
The average amount of time it takes to collect water, round trip, including queuing time - self reported by households	90	1.69
Outcome indicators: community hygiene		
Hand washing with soap and water following toilet use and before eating		
Hand washing station with water and soap is present in or near sanitation facilities and where food is prepared or consumed, and accessible to all household members - observational (consider height of station and ease of use for household members)	93	1.71
Community members have basic knowledge of hygiene practices		
Maternal head of household has knowledge of critical hand hygiene moments - question posed to maternal head of household	92	1.67
Hygiene related health promotion community outreach activities take place - self reported by maternal head of household	90	1.71
Outcome indicators: community sanitation		
Community is feces free		
Households have no evidence of feces in the living area - observational	84	1.84
No members of the community practice open defecation and children (under 5) stool is hygienically disposed - self reported by households	56	2.44
People report using a basic sanitation facility last time they defecated - self reported by households	81	1.93
Excreta is safely transported to a designated disposal/treatment site, or treated in situ before being re-used or returned to the environment - self reported by community waste managers	51	2.47

Continued

Table 2. *Continued*

Priority indicators[a] and associated metrics	% of 'very or somewhat feasible' responses	Average rank[b]
Presence of a functioning, clean toilet for household use		
Toilets are not broken and can be used by all members of the family - observational (consider the physical structure of the facility, household members age, disability, etc.)	84	1.78
The toilet facilities are not smelly, there is no visible feces in or around the facility, there are no flies, and there is no litter - observational	83	1.80
Outcome indicators: school water		
An improved water source is located on site and available for all children at school through-out the year		
An improved water source is on premises and water points are accessible to all users during school hours - self reported by students and staff, and observational (consider location and physical structure or water source)	94	1.48
How often water source is functional - self reported by students & staff	88	1.65
Improved water source is free from fecal contamination		
Water from source meets WHO guideline values for *E. coli* (less than 10 cfu *E. coli*/100 ml) - water sampling & testing	51	2.40
The water is from an improved water source, and assumed free from fecal contamination by nature of its construction - observational	77	1.81
Outcome indicators: school hygiene		
Hand washing with soap and water following toilet use and before eating		
Hand washing station with water and soap is present in or near sanitation facilities and where food is prepared or consumed, and accessible to all staff and students - observational (consider height of station and ease of use for staff and students)	91	1.71
Students have basic knowledge of hygiene practices		
Hygiene is taught in schools - self reported by teachers	96	1.36
Students have knowledge of critical hand hygiene moments - question posed to students	96	1.48
Outcome indicators: school sanitation		
School is feces free		
Students and staff report using a basic sanitation facility last time they defecated - self reported by students and staff	88	1.62
No students or staff practice open defecation - self reported by students and staff	78	1.87
Schools have no evidence of feces in or near school property - observational	84	1.71
Excreta is safely transported to a designated disposal/treatment site, or treated in situ before being re-used or returned to the environment - self reported by school waste managers	66	2.24
Presence of a functioning, clean toilet for staff and student use		
Toilets are not broken and can be used by all staff and students - observational (consider the physical structure of the facility, and staff/student age, disability, etc.)	92	1.60
The toilet facilities are not smelly, there is no visible feces in or around the facility, there are no flies, and there is no litter - observational	91	1.64
There are separate toilets for boys and girls		
There is at least one toilet for every 25 girls, at least one toilet for female school staff, a minimum of one toilet and one urinal for every 50 boys and at least one toilet for male school staff - observational	94	1.55
The number of functional toilets and urinals for boys, girls, and teachers meet national standards - observational	88	1.56

NTD: neglected tropical disease; WASH: water, sanitation and hygiene.
[a] Extracted based on ranking from Round 1.
[b] Metrics are ranked within each category between the number of metrics within the group. The best possible metric ranking is 1.

source provides enough water for all household needs, although this indicator was determined to be the least feasible (69%). The most feasible indicator was 'toilet accessible to those with disabilities' (84%), and was the second most preferred (average score 2.03), with the most respondents agreeing with the wording (84%).

Table 3. Round 3 results of indicator and metric pair rankings (n=60) and final indicator/metric pairs extracted from the study

Indicator and metric pairs	Average Rank[a]
Process indicators	
NTD sector National and District masterplans include WASH activities, targets, and indicators[b]	
Water, sanitation and hygiene are referenced and operationalized throughout NTD program strategies and plans (within targets, activities and monitoring) - self reported by NTD program coordinator	1.40
There is mutual representation of WASH and NTDs on National and District-level NTD Taskforces and WASH Sector coordination groups	
There is mutual representation of WASH and NTDs on National and District-level NTD task forces and WASH sector coordination groups	1.60
Outcome indicators: community	
Improved water source is free from fecal contamination	
The water is from an improved water source, and assumed free from fecal contamination by nature of its construction - observational	4.35
Water is consistently available in sufficient quantities for all domestic uses	
The water source provides enough water for the needs of the household, including water for drinking, hand washing, bathing, laundry, food preparation, morbidity management where needed, etc. - self reported by households	3.80
Improved water source is located such that it is within 30 minutes of collecting (including round trip walking and waiting time)	
The average amount of time it takes to collect water, round trip, including queuing time - self reported by households	4.67
Hand washing with soap and water following toilet use and before eating[b]	
Hand washing station with water and soap is present in or near sanitation facilities and where food is prepared or consumed, and accessible to all household members - observational (consider height of station and ease of use for household members)	3.56
Community members have basic knowledge of hygiene practices[b]	
Maternal head of household has knowledge of critical hand hygiene moments - Question posed to maternal head of household	3.54
Community is feces free	
Households have no evidence of feces in the living area - observational	4.39
Presence of a functioning, clean toilet for household use[b]	
Toilets are not broken and can be used by all members of the family - observational (consider the physical structure of the facility, household members age, disability, etc.)	3.67
Outcome indicators: school	
An improved water source is located on site and available for all children at school through-out the year[b]	
An improved water source is on premises and water points are accessible to all users during school hours - self reported by students and staff, and observational (consider location and physical structure or water source)	2.76
Hand washing with soap and water following toilet use and before eating[b]	
Hand washing station with water and soap is present in or near sanitation facilities and where food is prepared or consumed, and accessible to all staff and students - observational (consider height of station and ease of use for staff and students)	3.17
Students have basic knowledge of hygiene practices	
Hygiene is taught in schools - self reported by teachers	3.61
School is feces free	
Students and staff report using a basic sanitation facility last time they defecated - self reported by students and staff	4.37
Presence of a functioning, clean toilet for staff and student use[b]	
Toilets are not broken and can be used by all staff and students - observational (consider the physical structure of the facility, and staff/student age, disability, etc.)	2.93
There are separate toilets for boys and girls	
There is at least one toilet for every 25 girls, at least one toilet for female school staff, a minimum of one toilet and one urinal for every 50 boys and at least one toilet for male school staff - observational	4.17

NTD: neglected tropical disease; WASH: water, sanitation and hygiene.
[a] Indicator/metric pairs are ranked within each category between the number of indicator/metrics pairs within the group. The best possible indicator/metric pair ranking is 1.
[b] Final measurable indicators extracted from this study. One indicator/metric pair from process indicators, and three from each community and school outcome indicators were extracted.

Table 4. Round 4 results by disease and issue group

Indicator and Metric Pairs		Average Rank[a]	% of 'very or somewhat feasible' responses	% of people that agreed with wording
Trachoma (n=24)	Children have clean faces			
	% of children with clean faces (free of dirt and/or nasal and ocular discharge) among all children during program surveys and spot-checks/monitoring	1.29	67	83
	Community compound is visibly clean and free of human feces			
	% of households where compound is well swept and free of human feces, garbage pits and drying racks are present and in use for fly control	1.96	83	58
	Toilet facility includes fly control measures			
	% of toilet facilities that have fly control measures - vent, pipe and screen + cover of hole + screen in window	2.75	92	88
Soil transmitted helminths (n=13)	Children wear basic footwear			
	% of children wearing basic footwear among all children	2.23	77	69
	Hand washing before eating			
	Hand washing station with water and soap being present in or near where food is prepared or consumed, and accessible to all household members (consider height of station and ease of use for household members)	1.62	77	77
	Community members have basic knowledge of hygiene practices			
	Maternal head of household has knowledge of critical hand hygiene moments and thorough cooking - Question posed to maternal head of household	2.15	77	75
Schistosomiasis (n=12)	Community is feces free			
	Households have no evidence of feces in the living area	1.5	67	67
	Exclusive use of improved water source			
	% of schools with exclusive use of improved water source for all school needs (drinking, hand washing), in addition to bathing, laundry, food preparation, and washing of food-related utensils as relent	1.75	75	58
	Recreational use of water by children			
	% of households where children avoid regular contact with stagnant water for recreational use (self report)	2.75	42	73
Disease management, disability and inclusion (n=32)	Toilet is accessible to people with disabilities			
	Toilet is inside or just outside the household and is designed for the greatest level of independent use possible	2.03	84	84
	Water is consistently available in sufficient quantities to do activities of daily living and self care			
	Water source provides enough water for all household needs.	1.56	69	81
	Improved on site water source with universal design			
	% of households using an improved water source with universal design. Water source is accessible to all members of the community including men and women, boy and girls, older persons, people w/ impairments	2.41	78	75

[a] Indicator/metric pairs are ranked within each category between the number of indicator/metric pairs within the group. The best possible indicator ranking is 1.

Discussion

The purpose of this expert Delphi process was to identify a limited set of WASH indicators that could be used by NTD programmes and projects. A consensus on measurements of WASH is important for harmonized monitoring of integrated NTDs and cross-sectoral programmes. With WASH being integral to the successful control and eventual elimination or eradication of NTDs, incorporating WASH into NTD monitoring has the potential to support enhanced joint programming. The health benefits of this would be far reaching, as WASH interrupts many NTD transmission routes, and is important for both disease treatment and care.

The core indicators identified through this work are broadly applicable across many NTDs, for which there is a direct WASH link in terms of prevention and control. Disease specific indicators (e.g., face washing for trachoma) did not emerge as priority indicators, which is not surprising given the breadth of issues and experts included in the process. Our final list of joint indicators and metrics represent some agreement among experts in the WASH and NTD sectors about a limited set of data that should be collected across NTD programs. We believe that our results represent general agreement – although not necessarily consensus – among the large and diverse group of experts consulted. The resulting list of indicators is aligned and should supplement the proposed indicators under the WASH target of Sustainable Development Goal 6 as part of routine monitoring for programmes.[22] This list is not meant to be an exhaustive set of indicators, but a minimum set that would be consistent across programmes.

Because the final list of indicators did not include any disease specific indicators, we elected to conduct the final round (Round 4). While one survey round is insufficient for determining or generating consensus, and consensus may not be possible due to scientific uncertainties or difference of opinion between experts (for example regarding the importance of 'clean faces' for trachoma prevention), we hoped that the results would identify key issues and facilitate future efforts towards consensus within specific groups. The NNN WASH working group has recently developed a task team on joint monitoring, and will be using the findings of this exercise to stimulate joint monitoring discussions within specific disease/issue groups.

In addition to generating broad agreement on priority indicators for joint monitoring, this exercise highlighted the tension between 'importance' and 'feasibility' of indicators, played a role in informing participants about monitoring practices in both sectors, and created opportunities for further collaboration. Participants of the 2014 Roundtable noted that in global discussions such as this, the 'feasibility' of collecting data associated with indicators was often overlooked, with 'importance' taking precedence; however, in practice, feasibility is typically the ultimate consideration in project monitoring design (unpublished convener meeting notes). Therefore, this process took both importance and feasibility into consideration, and attempted to strike a balance during initial global discussions of joint monitoring. Limited or absent knowledge of existing WASH monitoring mechanisms, such as WASH Management Information Systems, WASH components of routine household surveys, and institutional responsibilities for planning and implementation of WASH services, was also a finding from the 2014 Roundtable.[17] Existing WASH sector indicators and definitions therefore formed the starting point for Round 1 of this study, supporting the development of a common understanding of WASH sector monitoring. Lastly, the strong data management skills of the NTD sector has previously been identified as an entry point for collaboration with the WASH sector.[15,16] By providing an introduction to WASH sector monitoring as well as an opportunity for comment on existing WASH indicators and metrics, this exercise has started foundational work required for capitalizing on this entry point. Qualitative feedback provided by participants throughout this study that identifies existing monitoring limitations and suggests ways in which to strengthen WASH indicators and metrics will be collated and used to take forward discussions with WASH partners at a later date.

Conclusions and way forward

We identified one process and six outcome indicators for joint WASH and NTD monitoring within the NTD sector. The final list represents general agreement of the opinions of a large number of diverse experts from both the WASH and NTD sector. The next step will be to integrate findings into existing NTD programme level monitoring, and to contribute to relevant discussions on national, regional, and global level monitoring. The NNN WASH working group is already taking this forward. Integration will likely come from specific NTD programmes working with country level water and sanitation departments to ensure that collection of data can be shared between government ministries or departments, and where possible, monitoring can be jointly undertaken. This process will differ across countries, and several NTD programs have already taken steps to jointly monitor WASH indicators (e.g., the Kenya trachoma program). Using existing examples on WASH integration in practice may provide guidance for other countries and programmes. Joint monitoring has been identified as one crucial component of the WHO Global Strategy on WASH and NTDs, as it is recognized as having the potential to greatly advance collaboration between the sectors.[10] Although this study was not endorsed through a WHO process, findings offer much insight on the development and implementation of joint monitoring frameworks. A key next step will be to conduct a similar exercise for joint monitoring from the perspective of the WASH sector monitoring NTD related indicators.

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